EFFECT OF SPLIT APPLICATION OF FERTILIZER ON YIELD, COMPONENTS OF YIELD, AND OTHER AGRONOMIC CHARACTERS OF RICE (V)*

W. L. Chang**

Experiments conducted at the Chiayi Agricultural Experiment Station in the past years have consistently indicated that application of nitrogen fertilizer was definitly effective in increasing grain yield of rice (Chang and Yang, 1964 a, 1964 b, 1966; Chang *et al.*, 1967). However, the effect of split application of potassium fertilizer was rather unstable. In the experiments conducted at Wan-tien-li Farm of this Station, it was found to be generally effective (Chang and Yang, 1964 a, 1964 b, 1966), but in the experiments of Tai-tou-ken Farm, there was no evidence of the effectiveness of split application of potassium fertilizer (Chang *et al.*, 1967). Split application of phosphorus fertilizer also failed to show any significant improvement in the production of rice (Chang and Yang, 1964 b).

An island wide experiment on the effect of split application of fertilizers which was sponsored by the Joint Commission on Rural Reconstruction and conducted by all the 7 District Agricultural Improvement Stations in 1965 and 1966 generally gave the similar results as those already obtained by this Station. However, before recommending this new technique of fertilizer application to farmers, more information concerning this method is still needed. Therefore, a follow-up coordinated experiment was started in 1967 to investigate the effectiveness of applying various rates of nitrogen fertilizer at the maximum tillering, the panicle formation, and the heading stages of rice development. This paper presents a brief summary of the experimental results obtained at this Station.

MATERIALS AND METHODS

Ammonium sulfate was used as source of nitrogen which was applied to rice in different combinations at various stages of growth as listed in Table 1. Calcium superphosphate and Potassium chloride were used as sources of P_2O_5 and K_2O which were applied at the rate of 60 kg per ha. The whole amount of P_2O_5 and half of K_2O were used as basal dressing and the other half of K_2O was applied at the time of second top dressing.

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** Agronomist, Chiayi Agricultural Experiment Station, TARI. The author is grateful to Dr. Y. S. Puh, Senior Specialist, JCRR, for his helpful advice during the course of this experiment.

Table 1. Treatments of nitrogen application* (Unit : kg/ha)

Treatment	Basic dressing	First top-dressing	Secon top-dressing	Third top-dressing or panicle fertilization	Fourth top-dressing or grain fertilization	Total
A	30	20	25	—	—	75
B	30	20	25	25	—	100
C	30	20	50	—	—	100
D	30	20	25	25	10	110
E	30	20	35	25	—	110
F	30	20	25	35	—	110

* Basic dressing: One day before transplanting.
First top-dressing: 30 days (1st crop) and 16 days (2nd crop) after transplanting.
Third top-dressing or panicle fetilization: Panicle formation stage or 60 days (1st crop) and 40 days (2nd crop) after transplanting.
Fourth top-dressing or grain fertilization: Heading stage or 82 days (1st crop) and 60 days (2nd crop) after transplanting.

The experiment was conducted at Tai-tou-ken Farm of the Chiayi Agricultural Experiment Station in both crops of 1967. The nature of the soil of the experimental plot was similar to that of the previous experiment (Chang *et al.*, 1967). Chianung 242, a typical panicle weight type of Japonica rice variety was used in the test. The plant spacing was 22.5 by 22.5 cm with 5 seedlings being transplanted at each hill. Climatic conditions were favorable for good rice growth during the test period.

The design of the experiment was a randomized complete block with 4 replications. Each plot consisted of 13 rows of 20 hills each from which 11 rows of 18 hills each or an area of 2.5 by 4m ($10m^2$ or 1/1,000 ha) was harvested for yield determination. Besides grain yield, data for heading date, maturity date, plant height, number of panicles per hill, panicle weight, panicle length, weight of 1,000 grains, and number of grains per panicle were also taken for the analysis of variance.

RESULTS AND DISCUSSION

Effect of Time of Nitrogen Application on Grain Yield and Its Components.

The average yield, components of yield, and F values for each treatment are given in Table 2. In the first crop, rice yield was generally in parallel with total amount of nitrogen applied, the higher the rate of nitrogen, the higher the yield. However, in the second crop, the relationship between grain yield and nitrogen rate was rather irregular, the higher rate of nitrogen did not necessarily resulted in a higher yield, indicating that the influence of rate of nitrogen on grain yield was not so pronunced in the second crop as it was in the first one.

Table 2. Effect of time of nitrogen fertilization on grain yield and its components of rice.

Treatment	Grain yield (kg/ha)		Number of panicles per hill		Number of grains per panicle		Weight of 1,000 grains (g)	
	1st crop, 1967	2nd crop, 1967	1st crop, 1967	2nd crop, 1967	1st crop, 1967	2nd crop, 1967	1st crop, 1967	2nd crop, 1967
A	5,964	4,854	13.3	8.8	118.5	150.6	29.5	29.0
B	6,131	5,326	12.1	9.4	128.4	157.4	29.8	30.5
C	6,231	4,870	13.2	10.1	128.5	141.1	29.0	29.0
D	6,268	5,256	13.1	8.8	128.6	151.4	29.8	29.3
E	6,270	5,537	13.1	9.4	126.6	159.9	29.8	29.5
F	6,585	5,020	13.0	9.6	144.5	144.7	30.3	29.5
Mean	6,242	5,144	13.0	9.4	129.2	150.9	29.7	29.5
F value	2.28	1.51	0.60	1.22	3.62	3.40	0.35	0.35
LSD 5%	—	—	—	—	13.31	11.7	—	—
LSD 1%	—	—	—	—	—	—	—	—

Treatment B yielded 100 kg or 2% lower per ha than treatment C in the first crop, showing that the same amount of nitrogen divided equally at both the maximum tillering and the panicle formation stages did not give better result than that top-dressed at the maximum tillering stage alone. However, treatment B outyielded treatment C by 456 kg or 9% per ha in the second crop, showing that additional top-dressing of nitrogen at the panicle formation stage was highly effective in raising yielding ability of rice in the second crop. This observation well agreed with those of the previous experiments conducted by this Station (Chang and Yang, 1966; Chang *et al.*, 1967), and that of Moomaw (1965). It appears, therefore, that panicle fertilization may not be a necessary factor for a high yield production in the first crop provided that sufficient amount of nitrogen is made available at the time of transplanting and at the maximum tillering stage, whereas in the second crop, panicle fertilization is undoubtly a prerequisite factor to a high yield, no matter now much nitrogen is applied as basal and top-dressings.

Treatment D top-dressed nitrogen at the heading stage in both crops. Since grain yields of this treatment were lower than those of treatment E which did not use grain fertilization in both crops, it seems likely that nitrogen application at heading stage may be unnecessary as long as sufficient nitrogen is applied before. The result of this experiment was generally similar to that of the previous one (Chang *et al.*, 1967). It appears probable that nitrogen application at heading stage or panicle fertilization may be effective only under certain fertilization system as suggested by Matsushima and Tanaka (1967). Treatments D, E, and F differed only in additional 10 kg of nitrogen per ha applied at heading, maximum tillering, and panicle formation stages, respectively. The differences in yields among these three treatments were not significant statistically, indi-

cating that changes of this portion of nitrogen did not affect yield greatly.

From the data of yield components, it was found that number of panicles per hill was not affected by the treatment. Treatments with higher grain yield were generally associated with more grains par panicle and larger 1,000-grain weight, showing that the increase in grain yield was caused largely by these two components. The result of this experiment was similar to that of Chang and Yang (1966) but differed with that of Chang *et al.* (1967).

Effect of Time of Nitrogen Application on Some Agronomic Traits of Rice.

A summary of the data and F values of some important agronomic traits are presented in Table 3. Heading date was not affected by the treatment in both crops, however, the maturity date of treatment D which applied nitrogen at heading stage, was longer than the other treatments especially in the second crop, indicating that nitrogen application at heading stage delayed maturity of rice. The difference in maturity date among treatments was significant at 1% level in the second crop. Plant height was generally associated with grain yield, the taller the plant, the higher the grain yield. Differences in plant height among treatments were highly significant in both crops. Since plant height is negatively correlated with lodging resistance factor (Chang, 1967), attention sould therefore be paid on the time of panicle fertilization to prevent excessive elongation of rice plant. Treatments applied nitrogen at panicle formation stage generally produced larger and heavier panicles than those without panicle fertilization, differences being statistically significant except that of panicle weight in the first crop.

Table 3. Effect of time of nitrogen fertilization on some agronomic traits of rice.

Treatment	Heading date (days)		Maturity date (days)		Plant height (cm)		Panicle length (cm)		Panicle weight (g)	
	1st crop, 1967	2nd crop, 1967	1st crop, 1967	2nd crop, 1967	1st crop, 1967	2nd crop, 1967	1st crop, 1967	2nd crop, 1967	1st crop, 1967	2nd crop, 1967
A	83	59	113	95	107.1	114.6	22.6	24.6	3.5	4.3
B	83	60	113	96	112.0	117.7	23.6	25.5	3.7	4.5
C	82	60	113	95	112.2	117.1	22.9	23.6	3.7	3.9
D	83	60	114	98	111.5	117.1	23.9	25.6	3.7	4.4
E	82	60	112	96	112.1	120.2	24.1	25.6	3.6	4.3
F	82	60	113	97	113.8	119.2	24.8	25.5	4.0	4.3
Mean	83	60	113	96	111.5	117.7	23.7	25.1	3.7	4.4
F value	0.32	0.41	2.21	9.33	7.88	8.77	5.93	8.03	2.75	3.67
LSD 5%	—	—	—	1.07	2.45	1.94	1.02	0.88	—	0.29
LSD 1%	—	—	—	1.48	3.38	2.68	1.41	1.21	—	—

SUMMARY

The effect of time of nitrogen application on grain yield, its components, and some agronomic traits of rice evaluated in both crops of 1967 at the Chiayi Agricultural Experiment Station are reported.

The application of nitrogen at panicle formation stage did not make itself felt in the first crop, however, it was highly effective in the second crop. The increase of yield appeared to be due largely to the increase in number of grains per panicle and weight of 1,000 grains. Top-dressing of nitrogen at heading stage did not contribute to the increase of grain yield.

Time of nitrogen application did not affect heading date, but maturity date was significantly delayed by application of nitrogen at heading stage. The nitrogen application at panicle formation stage generally produced larger and heavier panicles. There was also an indication for a tall plant to be associated with a high yielding ability.

LITERATURE CITED

1. Chang, T. T. 1967. Studies on lodging resistance. Ann. Rep. Int'l Rice Res. Inst. (1966) 79-81.
2. Chang, W. L. and S. C. Yang. 1964a. Effects of split application of fertilizer and planting density on yield, components of yield, and other agronomic characters of rice. Jour. Taiwan Agr. Res. 13(1): 16-27.
3. Chang, W. L. and S. C. Yang. 1964b. Effects of split application of fertilizer and planting density on yield, components of yield, and other agronomic characters of rice (II). Jour. Taiwan Agr. Res. 13(4): 1-10.
4. Chang, W. L. and S. C. Yang. 1966. Effects of split application of fertilizer and planting density on yield, components of yield, and other agronomic characters of rice (III). Jour. Taiwan Agr. Res. 15(1): 1-7.
5. Chang, W. L., S. C. Yang, and J. N. Chao. 1967. Effect of split application of fertilizer on yield, components of yield, and other agronomic characters of rice (IV). Jour. Taiwan Agr. Res. 16(2): 22-34.
6. Matsushima, S. and T. Tanaka, 1967. Decreasing basal dressing of nitrogen in accordance with increasing planting density of rice. Agr. and Hort. 42(2): 373-374.
7. Moomaw, J. C. 1965. Time of nitrogen application. Ann. Rep. Int'l Rice Res. Inst. (1964) 94-96.

肥料分施對水稻產量、產量構成因素、及其他農藝性狀之效果（五）

張　萬　來

摘　要

本文係報告嘉義農業試驗分所於民國56年承辦全省性水稻肥料分施試驗所得之結果。

在幼穗形成期施用氮肥之效果，對第一期作水稻產量之影響不大，但對第二期作水稻却有明顯之增產效果，其增產原因爲每穗粒數與千粒重之增加，在抽穗期施用氮肥未見成效。

氮肥分施不影響生育日數，但抽穗期施用氮肥可延遲水稻之成熟期。幼穗形成期施用氮肥，有利於株高，穗長及穗重之發育。